PATENT SPECIFICATION

722,611

Date of Application and filing Complete Specification: Dec. 31, 1951. *No. 30462/51.*

Application made in United States of America on Jan. 5, 1951.

Complete Specification Published: Jan. 26, 1955.

Index at acceptance:—**Classes 80(2),** C1A(1B:2:4:7B:11A), C1E1; C2(A3B:F4E); **and 83(3),** N2A(2:3:4), N(2E2:3C4)

COMPLETE SPECIFICATION

Rotary Impact Wrench

I, SPENCER BENNETT MAURER, a Citizen of the United States of America, residing at 6522 Wilson Mills Road, Highland Heights, Cleveland, Ohio, United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to portable, power-operated, impact wrenches and similar tools for driving bolts, nuts, screws, and the like or for applying a rotational impact force to other objects, all such tools being hereinafter generically referred to as impact wrenches.

The usual tool of this character comprises three basic parts, namely, a prime mover, such as an air or electric motor, a rotatable hammer driven by the prime mover and having a high moment of inertia and a rotatable output or work shaft, including an anvil member adapted to be struck by the hammer for imparting a high torque to the output shaft. The hammer member is disengageable from the anvil member to permit the prime mover to rotate the hammer member freely for imparting a high angular momentum thereto, and a clutch mechanism is provided for repeatedly engaging the rotating hammer and the stationary anvil to apply the momentum of the hammer member to the anvil and to the output shaft. The clutch mechanism is also adapted to disengage the hammer from the anvil when the resistance to rotation of the output shaft has stalled the prime mover, thereby permitting free rotation of the hammer member for again building up its angular momentum. This cycle of operation is repeated until the power to the prime mover is cut off, the rapidity of the cycle and the magnitude of the torque applied being dependent upon a number of factors, including the rotational resistance of the object to be driven, the construction and mode of operation of the clutch mechanism, and the power and acceleration of the prime mover.

[*Price* 2/8]

One of the principal problems involved in producing an impact wrench is to provide a driving connection between the prime mover and the impact hammer and at the same time protect the comparatively delicate parts of the prime mover from the relatively heavy shock loads due to rapid deceleration during impact.

The principal object of the present invention is to provide an improved rotary impact wrench wherein the power connection between the rotor and the hammer protects the motor against unduly high shock loads.

Another object of the present invention is to provide a power connection between the rotor and the hammer of a rotary impact wrench which reduces the stresses to which the rotor is subject in its operation, thereby permitting the use of much lighter rotor construction.

A further object of the present invention is to provide a much more reliable and rugged rotary impact wrench.

A further object of the present invention is to provide a rotary impact wrench which is less fatiguing to the operator due to lower vibrational forces being imparted to the operator's hand.

Another object of the present invention is to provide a rotary impact wrench having an extremely simple, inexpensive, yet rugged, valve whose valve action is very rapid and positive.

A further object of the present invention is to provide a rotary impact wrench having very few parts, thereby achieving an inexpensive, yet reliable construction.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

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In the drawings:—

Fig. 1 is a cross-sectional view of a rotary impact tool showing the features of this invention;

Fig. 2 is a sectional view taken along line 2—2 of Fig. 1, showing in particular the rotor construction;

Fig. 3 is a sectional view taken along line 3—3 of Fig. 1 and showing in particular the air inlet ports to the rotor;

Fig. 4 is a sectional view taken along line 4—4 of Fig. 1 and showing in particular the reverse valve mechanism;

Fig. 5 is a sectional view taken along line 5—5 of Fig. 1 showing the clutch control valve mechanism;

Fig. 6 is a sectional view taken along line 6—6 of Fig. 1 showing the hammer;

Fig. 7 is a sectional view taken along line 7—7 of Fig. 1, showing the anvil; and

Figs. 8 and 9 are sectional views of a modified form of the invention.

In the drawings there is shown a rotary impact wrench embodying an air motor and a clutch mechanism, a portion of the fluid under pressure (in this case compressed air) normally supplied to the tool for driving the motor being by-passed to the clutch mechanism, where it is employed to effect both engagement and disengagement of the hammer and anvil. Centrifugal force is employed to assist in the control of the clutch, by solely operating a simple valve in the compressed air system. The primary forces responsible for an operation of the clutch are applied to the mechanism entirely by compressed air. As shown in Fig. 1, the tool is mounted in a housing that may conveniently comprise an integral handle and motor housing section 10 and a separate housing section 11 containing or mounting the parts of the device driven by the motor. The two housing sections 10 and 11 may be suitably threaded together or otherwise secured in any conventional manner.

The motor, the controls therefor, and the compressed air supply line leading to the motor may, for the most part, be of any conventional design and need not be described in detail. Essentially this portion of the device includes a coupling 12 for a compressed air hose 13 that leads into the handle portion of the housing section 10 and to a main control valve contained therein (not shown). A trigger 14 is mounted on the handle portion for actuating the main control valve, from which a main air conduit 16 leads toward the motor. The air in the main air conduit 16 passes through a reverse valve 17 interposed between the main air conduit 16 and the motor for controlling in a well known manner the supply of air selectively either to the manifold 18 for forward operation of the motor or to the manifold 19 for reverse or clockwise rotation of the motor. The air enters the cylindrical air chamber 21 either through the ports 22 or the ports 23, drives the rotor by pressure on the vanes 24, and is exhausted through the exhaust port 26 and exhaust conduit 27. The rotor 28 is eccentrically mounted with respect to the liner C in the rotor chamber, and the vanes 24 are slidably mounted in the radial slots in the rotor and are urged outwardly against the liner of the rotor chamber by air pressure through ports A for forward motion and through ports B for reverse motion. The air entering the rotor chamber between each adjacent pair of vanes moves the vanes about the rotor axis in the direction to enlarge the space therebetween and permit expansion of the air as it travels toward the exhaust port 26. The valve 17 that controls the direction of the rotation of the rotor is manually controlled by the slide valve 29 presently shown in position for forward rotation.

The rotor 28 is mounted on a hollow drive shaft 31 by means of a coupling sleeve 32 of rubber or like material which frictionally engages both the rotor 28 and the drive shaft 31. To assemble the rotor and the drive shaft, the rubber sleeve 32 is slipped on over the drive shaft 31 with one end of the rubber sleeve against the shoulder D on the drive shaft and with the other end of the rubber sleeve 32 extending beyond the location of the end of the rotor 28. The rotor 28 is then pushed into position over the rubber sleeve 32 and a collar 33, which fits tightly around the metal drive shaft 31, is slid into position against the end of the rubber sleeve 32 to compress the rubber and cause the rubber to frictionally engage both the drive shaft 31 and the rotor 28 to provide a frictional coupling between the two members. Ball bearings 34 are provided on the forward and rearward ends of the drive shaft and a snap ring E is connected to the collar 33 to hold the rearward ball bearing 34 in place. This provides a driving connection of sufficient torque to transmit the normal motor torque to the hammer with essentially no slippage but to allow slippage during periods of rapid deceleration of the hammer and drive shaft so that the rotor body is never rapidly decelerating and the kinetic energy and momentum of the rotor body are dissipated in the form of heat at the slipping surface, the advantage of this being that the rather light and delicate rotor body is not subjected to heavy shock loads or stresses.

The output shaft 37 is journalled in a bushing 38 carried by the housing section 11 and terminates at one end in a suitable work driving tip 39. The bushing 38 is sufficiently long to hold the output shaft 37 firmly in alignment with the axis of the drive shaft 31 and to permit the clutch assembly to be supported solely by and between the output shaft 37 and the hollow drive shaft 31, in a

manner hereinafter described. The output shaft 37 is provided with a circumferential shoulder portion 41 for retaining the shaft in the bushing 38. A projection 43 from the shoulder portion 41 of the output shaft 37 constitutes an anvil and is shaped on opposite sides to provide identical impact surfaces 44 against which a hammer 48 may strike to drive the output shaft in either direction about its axis. The hammer 48 includes a projection 48′ which may project into the path of radial projection 43 of the anvil member. The clutch assembly is constructed around a relatively massive hollow hammer 48. The forward end of the hammer body 48 is splined to the spindle 49 by spline teeth 50 and is supported for rotary motion with the spindle and is capable of axial motion relative to this spindle. A steel ring 51 is mounted between the hammer 48 and the spindle 49 at the rearward end thereof and a snap ring 52 connects the steel ring 51 to the hammer body 48 so that the hammer body 48, the steel ring 51, and the snap ring 52 move axially as a unit with respect to the spindle 49. An annular opening 53 is provided between the hammer 48 and the spindle 49. Air under pressure fills this opening 53 and exerts a driving force directed forwardly against the face 54 of the hammer 48. Another annular opening 55 is provided between the hammer 48, the steel ring 51, and the spindle 49. When air under pressure is admitted to the opening 55 it drives the hammer unit comprised of the hammer 48, the steel ring 51, and the connecting ring 52 toward the rear of the tool to disengage the projecting lug 48′ from the anvil face 44.

A valve mechanism 60 is provided for controlling the air into the annular space 55 to intermittently connect the space 55 to the source 16 of air under pressure and to atmospheric air to permit the air under pressure in the annular space 53 to slide the hammer 48 forward. Air under pressure is provided to the annular space 53 from the source 16 through the valve 17, through the drilled passageway 61 to the hollow drive shaft 31 and to the space 62 under the valve body 60. From the space 62 this air under pressure passes through drilled passageway 63 to the annular space 53. The air in annular space 53 fills the space 64 between the hammer shell 48 and the top surface of the valve 60, thereby balancing the air pressure acting on both sides of the valve 60. The valve 60 includes a stem portion 65 which extends into a guide passage 66 in the body of the spindle 49. The passage 66 extends to an opening 67 which is vented through an annular space 68 and drilled passageways 69 and 70 and out through the front of the output shaft 39. While the air pressures on the top and bottom surfaces of the valve 60 are balanced, the areas on the top and bottom surface over which their air pressure is active is slightly greater in favour of the outer surface due to the stem 65 blocking off a portion of the air under pressure in space 62. The net result is a slight force biasing the valve 60 inwardly toward the axis of the tool.

Fig. 1 shows the valve 60 in its outward position where it is forced by centrifugal action which overcomes the slight air bias. In the position shown in Fig. 1 with the valve 60 in its outward position, the annular space 55 is vented to atmosphere through openings 73 opening into a groove 71 around the valve 60 and an opening 72 in the spindle body 49 to the vented annular space 68. This causes the air under pressure in the annular space 53 to push the hammer 48 forward into engagement with the anvil 43 thereby from the inertia of the hammer striking a blow which is used for driving or removing nuts, bolts, or the like. At the termination of an impact, the hammer and spindle have lost their angular velocity and are standing essentially still. Therefore, the centrifugal force previously acting on valve 60 has disappeared and the air bias becomes predominant and moves the valve body 60 radially inward to a position where ports 73 are now connected to the live air of annular chamber 53 and 64. This allows air under pressure to reach the larger areas of chamber 55 which produces a rearwardly acting force on the hammer body 48 which exceeds the opposing force from the air in chamber 53, thus causing the hammer body to be moved in a rearward direction and disengages the impact projection 48′ from the anvil 43 thus allowing the motor to again accelerate the hammer assembly.

The clutch is lubricated periodically by grease supplied through grease fitting 80, through several holes 81 drilled in the bushing 38, and through a hole 82 in the output shaft to the proximity of the impact jaws. In this manner grease is supplied to all of the bearing surfaces in the front end of the impact clutch. In order to retain the necessary minimum amount of grease in the clutch chamber at all times, the vent 69 in the forward end of the spindle is the only opening through which grease could leak to the outside of the tool: but since this opening is essentially centrally located within the clutch chamber, it is impossible for all of the grease to run out or be blown out of the clutch housing. As the tool is tilted to the various operating positions, there is always a sufficient volume of space in the clutch housing which is at a lower level than the opening of this passage 69 and therefore the grease will not tend to run out.

Figs. 8 and 9 show an alternative embodiment of the friction drive feature of the invention and an alternative clutch mechanism for coupling the motor to the hammer.

The motor, the controls therefor, and the

compressed air supply line leading to the motor may, for the most part, be of any conventional design and are not here described in detail. For a brief description of the parts, reference may be made to the device shown in Figs. 1 to 7.

In the embodiment shown in Figs. 8 and 9 the rotor 28 and the drive shaft 31 are connected by spline 30 to a cone driver 35 for causing the cone driver to rotate with the rotor 28 and drive shaft 31. The hammer 48 has a conical surface portion 36 which is adapted to be frictionally engaged by the inclined face of the cone driver 35. A spring 40 biases the cone driver into engagement with the conical surface portion 36 of the hammer 48. The spring 40 is held in place by a retaining ring 42 the outer edge of which is locked in a groove 45 in the hammer 48. Rotation of the cone driver 35 causes the hammer 48 to rotate.

The hammer 48 is comprised of a clutch body 85, a piston 86, a valve pin 87, a centrifugal weight 88, and an impact pin 89. The clutch body is mounted for rotary motion by means of the cone driver at one end and by means of the output shaft 90 at the other end. The clutch body 85 has a hollow central portion and has a groove 91 which receives a portion of the centrifugal weight 88 to permit the weight to slide radially across the tool. One end of the valve pin 87 is in engagement with an upstanding portion 88′ of the centrifugal weight and the other end of the valve pin is mounted for sliding motion within a bore 92 in the piston 86. The valve pin 87 includes an enlarged shoulder portion 93 which sealingly engages the walls of the bore 92. The piston 86 is mounted within the hollow central portion of the clutch body 85 and is connected to the impact pin 89 by means of the projecting lug 94 which fits in a slot 95 in the impact pin. The piston 86 and the impact pin 89 are mounted for axial motion with respect to the tool. When the impact pin is in the forward position shown in the drawing, its front end is in engagement with the impact receiving portion 96 of the output shaft 90, as described in detail in the other embodiment of the invention.

When the impact pin is in its backward or withdrawn position its front end is disengaged from the impact receiving portion 96.

The operating cycle is as follows: starting from the position shown in the drawing where the torque resistance of the work is greater than the output torque of the motor and the motor is stalled. The impact pin is in engagement with the output shaft. Air pressure in the hollow recess 97 in the piston 86 reaches the shoulder portion 93 of the pin 87 through port 98 and constantly urges the pin 87 against the portion 88′ of the centrifugal weight 88 to force the weight radially to the right as shown in Fig. 8. This moves the shoulder portion 93 past the port 99 to allow compressed air from port 98 to travel through port 99 to the chamber 100 at the front face of the piston 86. This pushes the piston 86 rearwardly, carrying with it impact pin 89, thus disengaging the impact pin from the output shaft 90 and allowing the rotor 28 to accelerate the hammer unit 48. Before the hammer unit rotates one complete revolution, the centrifugal force acting on the weight 88 becomes sufficient to overcome the fluid force on the shoulder 93 of the valve pin 87 causing the pin 87 to move radially inwardly to a position such that the shoulder portion 93 effects a seal between the ports 98 and 99 thus disconnecting port 99 from its source of fluid pressure and opening port 99 to atmosphere pressure within the clutch housing thus allowing the air pressure in chamber 100 previously acting on the clutch face to disappear. The air pressure in chamber 97 causes the piston to move forwardly forcing the impact pin 89 into engagement with the output shaft 90, so that by the time the hammer unit has completed one revolution the impact pin 89 is in position to engage the impact receiving face 96 of the output shaft 90.

The torque required to produce slippage between the cone driver 35 and the conical surface portion 36 of the hammer 48 is greater than the maximum output torque of the rotor, but is not great enough to prevent slippage during an impact due to the momentum of the rotor 28. This slippage prevents excessive impact shock loads from reaching the rotor 28.

A feature of the invention is the two-part threaded-together housing and the means for locking the two parts of the housing together. Previous attempts at assemblies of the type described have encountered difficulty in preventing undesired loosening of the mating parts during operation of the tool. In the present invention this has been overcome by using a pinch bolt 105. The housing section 106 encloses the motor unit and the housing section 107 encloses the clutch parts. The two housing sections are threaded together. One of them, for example housing section 106, carries the female threads, and is provided at the thread area with two spaced-apart outwardly extending lugs 108, 109 with a space 110 running up through the threads. A threaded bore 111 extends through the lugs 108, in a direction perpendicular to the axis of the tool and preferably at a location below the threads in the housing portions 106, 107. Screwing the pinch bolt tightly into position after the two housing portions have been threaded together squeezes the lugs 108, 109 together greatly increasing the radial force between the two threaded housing portions, setting up a higher frictional locking force

than is otherwise obtained. It has been found that the vibratory action of the tool tends to increase the tightness of the connection rather than to loosen it.

What I claim is:—

1. A rotary impact wrench comprising a rotatable output shaft including an anvil, rotatable hammer means, means for periodically causing the hammer means to engage the anvil to prevent relative rotation therebetween to impart a blow to the anvil, automatic means for disengaging the hammer means from the anvil upon termination of the blow, a rotatable motor, means rotatable by the motor for driving the hammer means and frictional driving means between the rotatable hammer driving means and the motor for frictionally transmitting rotational forces from the motor to the rotatable hammer driving means and for permitting slippage as the motor decelerates when the blow is imparted.

2. A rotary impact wrench according to Claim 1 in which the rotatable hammer driving means include a drive shaft connected with the hammer means, the frictional driving means being provided between the motor and the drive shaft.

3. A rotary impact wrench according to Claim 2 in which the motor has a rotor having a bore in which the drive shaft is located and the frictional driving means is a rubber-like body coupling the rotor to the drive shaft.

4. A rotary impact wrench according to Claim 3 in which the rubber-like body is a rubber-like sleeve around and in engagement with the drive shaft and in engagement with the rotor wall defining the bore.

5. A rotary impact wrench according to Claim 4 in which the drive shaft has a shoulder portion connected thereto at one end of the sleeve against which portion the sleeve abuts and compression means are secured round the drive shaft at the other end of the sleeve compressing the sleeve lengthwise between the shoulder portion and the compression means so that the sleeve is expanded radially into close frictional engagement with both the rotor and the shaft.

6. A rotary impact wrench according to Claim 1 in which the motor comprises a rotor having a driving shaft connected thereto and the rotatable hammer driving means include a shaft, the frictional driving means being provided between the shaft of the rotatable hammer driving means and the driving shaft.

7. A rotary impact wrench according to Claim 6 in which the frictional driving means comprise two frictionally engaging members carried by the driving shaft and the shaft of the hammer driving means respectively and urged into frictional engagement one with the other by resilient means.

8. A rotary impact wrench comprising a driving rotor having a bore for a shaft, driven tool driving means including a drive shaft located within the bore in said rotor, and a rubber-like body in frictional engagement with said shaft and said rotor coupling said rotor to said shaft.

9. A rotary impact wrench comprising rotatable motor means including a rotor having a bore for a shaft, rotatable work means for intermittently delivering blows including a drive shaft located within the bore in said rotor, and a rubber-like sleeve around and in engagement with said shaft and in engagement with the portions of said rotor defining said bore frictionally coupling said motor means to said rotatable work means.

10. A rotary impact wrench according to Claim 9, further characterised by a shoulder portion connected to said shaft at one end of said sleeve against which said sleeve abuts, and compression means secured around said shaft at the other end of said sleeve compressing said sleeve lengthwise between said shoulder portion and said compression means thereby expanding said sleeve radially into close frictional engagement with both said rotor and said shaft.

11. A rotary impact wrench substantially as herein described with reference to the accompanying drawings.

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Printed for Her Majesty's Stationery Office by Wickes & Andrews, Ltd., E.C.4. 39/244.—1954.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

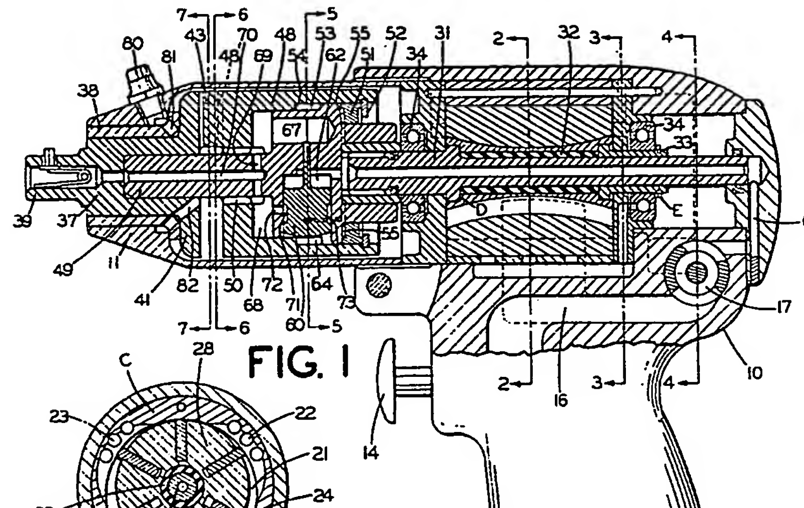

FIG. 1

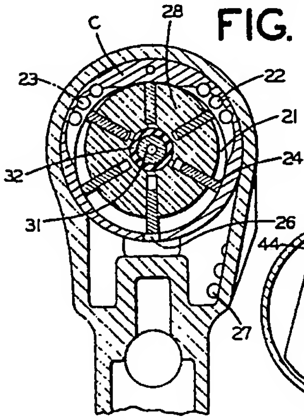

FIG. 2

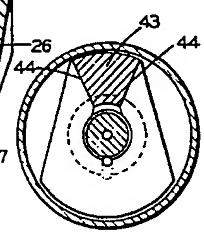

FIG. 7

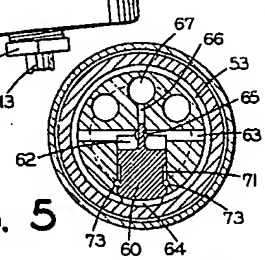

FIG. 5

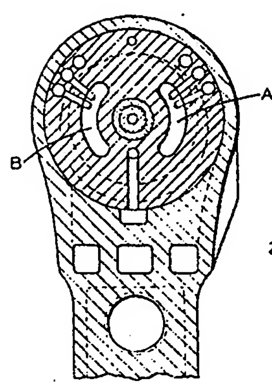

FIG. 3

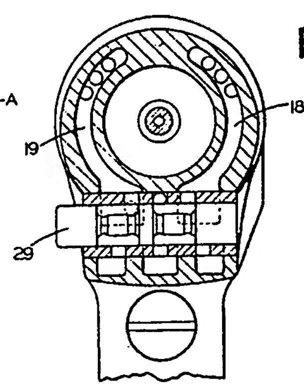

FIG. 4

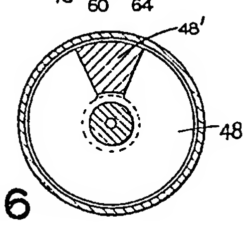

FIG. 6

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2 SHEETS

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SHEETS 1 & 2

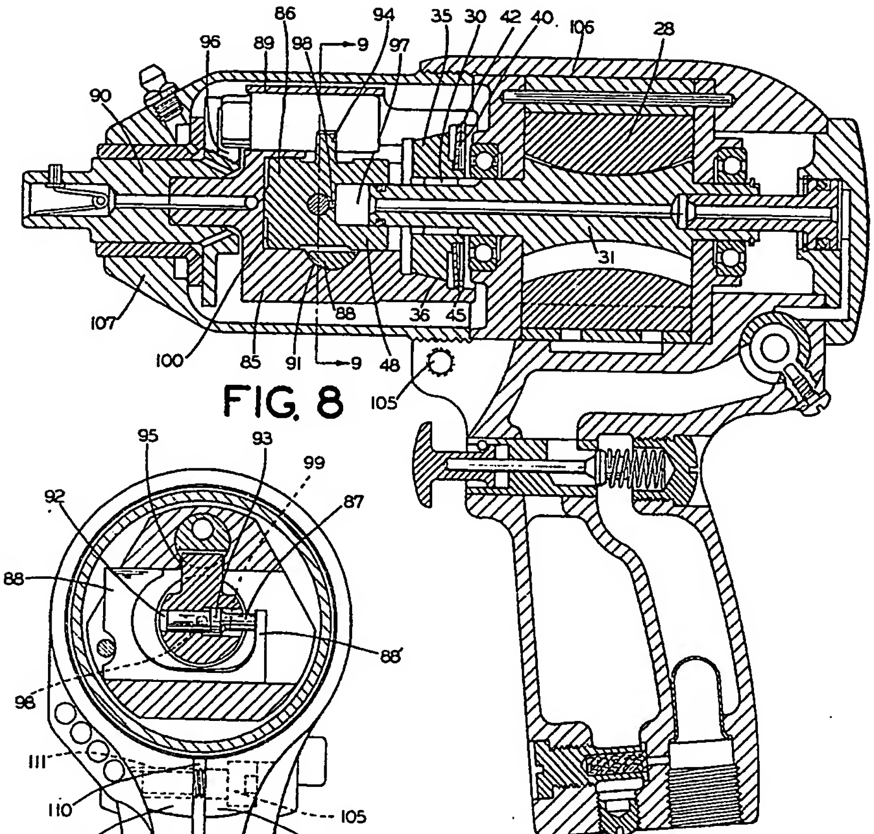

FIG. 8

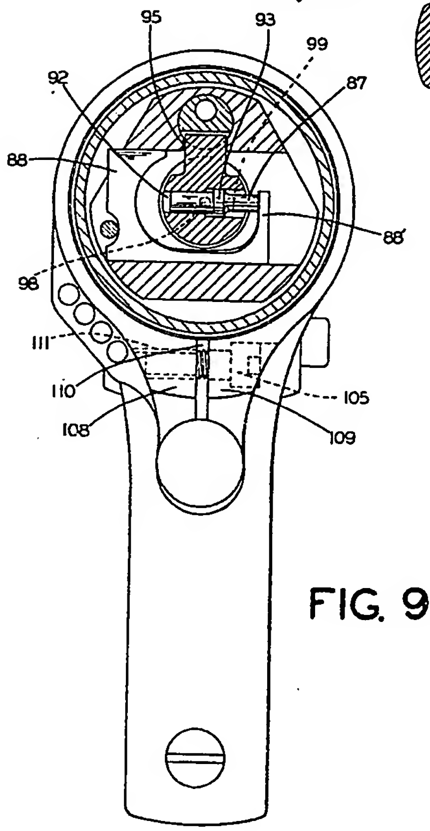

FIG. 9

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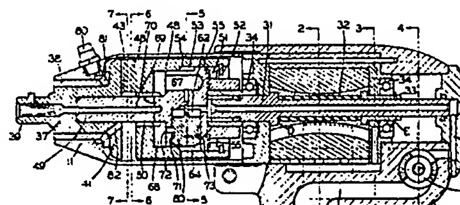

FIG. 1

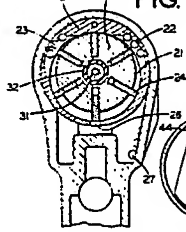

FIG. 2

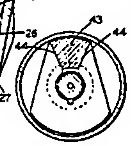

FIG. 7

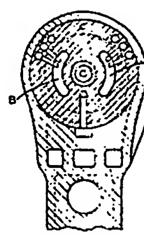

FIG. 3

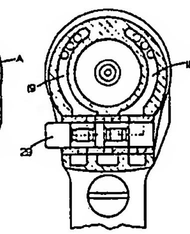

FIG. 4

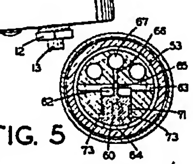

FIG. 5

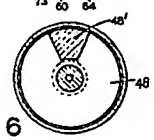

FIG. 6

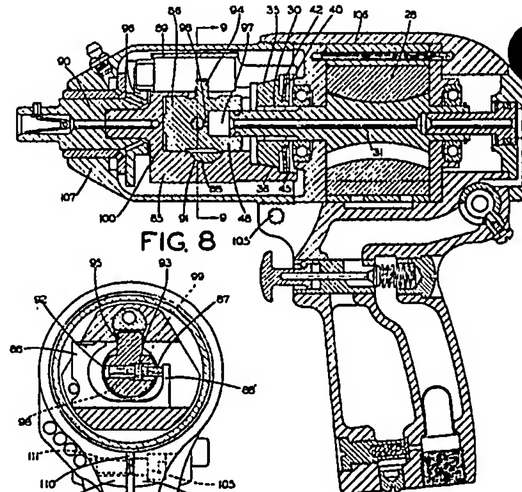

FIG. 8

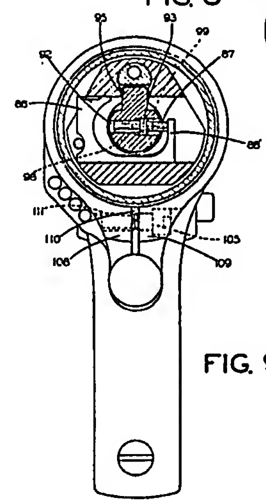

FIG. 9